AUTOMATED EXECUTION AND RISK MANAGEMENT OF TRANSACTIONS IN SECURITIES

COMPUTER LISTING APPENDIX

This application includes a Computer Listing Appendix on compact disc, hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an integrated computer network that enables a market maker to deliver to front end users/investors an automated execution service for securities transactions, typically for larger sized orders, that enhances the speed and certainty of executions, and which manages a market maker's trading and inventory risk by integrating internal order book and multiple market venues selected based on their trading characteristics.

2. Description of the Prior Art

[0002] As a result of the evolution and proliferation of various markets and venues for trading securities in the United States and abroad, investors often find it difficult to purchase or sell securities on an automated basis, particularly in larger quantities. Securities of individual companies often trade in several different markets or venues and investors need access to these market venues to fill larger orders. Firms that intermediate these transactions, such as dealers, market makers and exchange specialists, typically do not meet all of the investor demand for executing larger size orders and with the speed and certainty of an automated execution. Some intermediaries offer automated execution services but impose order size limitations or restrict use of the system if spreads are too narrow, during locked and crossed markets (i.e., markets where bid and ask prices are equal or inverted) and other market conditions. Market maker auto-execute capabilities for executing larger orders have been decreasing due to speed, fee and access impediments of certain market venues and the capital necessary to execute the full size of an order and/or the difficulty in quickly trading out of a large order or otherwise reducing or managing inventory risk.

[0003] Securities markets today, particularly in the United States, suffer from various structural inefficiencies that, while fostering price competition, inhibit efficient trading by investors and market makers in an electronic environment. The main inefficiencies include market "fragmentation" or multiple trading venues, the lack of depth or liquidity in each market venue, and the time and number of executions necessary to execute the full size of an order and receive notice of its completion. In addition, narrowing spreads caused in part by decimal pricing, increased incidents of locked and crossed markets, access fees to alternative markets and other factors have made it more difficult for market makers to devote capital and manage inventory risk

necessary to execute customer transactions automatically, particularly for larger sized orders.

[0004] Market fragmentation occurs when the securities of an individual company trade in more than one market or venue. Investors or market makers, therefore, may need to send orders to many different public and private markets or venues to complete the full size of an order. This process often takes time and can result in partial executions and lost opportunities to obtain execution immediately. Prices and the number of securities available to purchase or sell can change instantaneously, making the speed and the likelihood of execution important factors in deciding what market or markets to direct the order for execution. Each market venue also has different modes and protocols of electronic order entry, execution and confirmation; special access, membership and/or transaction fees; and differences in execution speed and quality.

[0005] There are several market venues that offer computer linkage to facilitate automated executions. Under a single securities exchange model, such as the New York Stock Exchange, Inc., one specialist for each security traded on the exchange has an obligation to set bid and ask quotes, and to execute purchase or sell orders, in rising and falling markets. Orders can come to a specialist's booth by telephone or from other brokers physically on the floor of the exchange. Other orders can come in electronically, and the NYSE has different electronic systems to execute different size orders. Specialists and other brokers submitting orders or trading interest are displayed on a computer terminal on the floor near the specialist's booth. Electronic orders coming in may be matched up against the orders displayed in the specialist's computer terminal. Last sale information is reported to the consolidated tape for public dissemination. Therefore, the price, depth and trading interest is largely contained in an integrated market, and with one specialist acting as the sole market maker for the security on the exchange.

[0006] In contrast, securities listed on the Nasdaq Stock Market, Inc. (Nasdaq), an interdealer quotation system consisting of competing market makers for each security linked together by a network of computer systems, are traded by many different dealers acting as market makers, each offering different firm bid and ask quotations and at size levels selected by the market maker. All market makers, and broker-dealers routing orders to market makers, interact electronically through a network of computer terminals, where bid and ask prices and related volume levels are displayed on Nasdaq's centralized SuperMontage (SM) system. Nasdaq SM also contains an order routing computer network. Nasdaq SM aggregates quotes and orders at each price level, and dynamically displays on a computer screen on a real time basis a "montage" of quotation information, including the best prices of all participants, with corresponding size on each side of the market.

[0007] The Nasdaq SM displays information to computer terminals at three levels. In particular, Nasdaq Level I permits members to view real-time access to inside market quotations at the national best bid and offer (NBBO) and quotations of individual market makers. Nasdaq Level II includes Level I and permits participants to view on a real-time basis all trading interest by participating Nasdaq market makers, dealers and other market venues that submit bid and ask quotes to Nasdaq for inclusion in the SM. Nasdaq Level III permits market makers only to input or change bid or offer quotations and the size or number of shares they are willing to purchase or sell at given price levels and to receive and execute incoming orders. Depending on the security listed on Nasdaq, there may be only a few market makers, or there may be many market makers, sometimes averaging 70 or more different firms, in the security and quoting multiple price and size levels. Various market systems display Level II and Level III data, for example, as disclosed in U.S. patent no. 5,297,032 to Trojan, et al., issued Mar. 22, 1994. Nasdaq charges a fee for each transaction, as well as any electronic exchange executing an order.

[0008] The securities of some companies listed on Nasdaq have also been granted "unlisted trading privileges" (UTP) such that those Nasdaq listed securities may also be traded on the NYSE and regional stock exchanges, such as the Cincinnati Stock Exchange, Inc., the American Stock Exchange, Inc., the Chicago Stock Exchange, Inc., the Pacific Exchange, Inc. or the Boston Stock Exchange, Inc., among others. Quotes from these exchange specialists or market makers are included in the Nasdaq SM and displayed along side market maker quotes. If an exchange specialist quote establishes the national best bid or offer and is displayed on Nasdaq's SM, or if an order routing firm selects or preferences an exchange for execution of the order, the order entered into the SM would be routed electronically from the SM to the exchange for automated execution depending on the exchange trading protocols, including different time requirements in which an order is executed. Some exchanges require separate linkages and their quotes are not accessible through Nasdaq's SM.

[0009] In addition to Nasdaq SM and UTP exchanges, Nasdaq listed and other securities can trade in Alternative Trading Systems (ATSs), which include electronic communication networks (ECNs). Typically, ECNs are private trading venues for professional members, and each member obtains a separate computer trading terminal that is linked or connected to the ECN and its centralized order book and trading system. The ECN consolidated order book computer keeps track on a real-time basis of member bids and offers, and resulting transactions, and will automatically match or execute eligible orders electronically. Each member's trading terminal will be updated to reflect the transaction and to update the order book to take out the price and size of the executed transaction. Members may input additional bids or offers, automatically update their quotes if they designate additional or reserve size and other functionality. Membership in an ECN typically is limited to institutional investors, broker-dealers, specialists and other market professionals; retail investors typically need to use a broker or dealer to access ECN quotations, including resulting delays in execution due to the

lack of direct access. Each ECN has different electronic trading mechanics and protocols, and charge various access fees, as well as transaction fees based on the volume of each transaction. The total number of ECNs at one time was eight, including Instinet, Island, Brut, Archipelago, each representing a different market venue that may execute transactions electronically for members.

[0010] An additional market venue includes the process whereby dealers or market makers "internalize" orders and execute them as principal internally, without placing orders into Nasdaq SM, any ECN or other market for publication or interaction with other orders, or including such orders in their own market maker quotes. Dealer internalized orders represent additional pools of hidden liquidity that are not included in public quotation venues, but can be used by market makers to fill other customer orders on the other side of the market. If executed on a net price basis, the internalized order execution may not be included in any public quotations in any separate last sale figures, thereby reducing market impact of the execution.

[0011] The Securities and Exchange Commission (SEC) has required some trading venues to be linked, such that prices entered by market makers or exchange specialists in ECNs that are better than their public quotes must be displayed publicly, such as in the Nasdaq SM system. Also, if broker-dealers receive customer limit orders (orders at a limit price), they may either execute the orders, include the order in their own market making bid, or display the order in an alternative market, such as an ECN that is electronically linked to Nasdaq SM to permit public display of the limit order (unless the customer requests that the order not be displayed). Orders from other institutional members of ECNs, however, need not be displayed in a public quotation system, and possible pools of liquidity are accessible by members only, unless the ECN represents five percent or more of the trading volume in a particular security.

[0012] The number of securities offered for sale or purchasers by market makers at the NBBO, even if several market makers each may be quoting the best bid or offer

nationally, may not be large enough to fill larger sized orders. Therefore, if a customer wants to purchase or sell securities at a volume level larger than the NBBO, it may need to seek out alternative markets or trading venues to execute the full size of the order and at prices outside or inferior to the NBBO. The consolidated firm quotes of market makers, ECNs or exchange specialists at the NBBO may be thin, meaning such firms would be obligated to purchase or sell only a limited number of shares at the NBBO. Other market makers or dealers offering to quote at different price levels just below or above the NBBO also may not be willing to commit their capital to purchase or sell shares in any large amount.

[0013] Therefore, the depth of a security's available liquidity typically may not be located in one market venue, but may be quoted in several market venues (or may be internalized on a dealer's limit order book), only some of which are accessible by brokers, dealers, market makers, or in Nasdaq SM. In order to reach that liquidity necessary to purchase or sell shares, an investor, dealer or market maker may need to interact with many different market venues or pools of liquidity, at different prices, to execute the complete size of the order. In addition, the customer would need to pay for "ticket" charges (clearance and settlement fees) and/or transaction fees for each execution necessary to complete the full size of the order.

[0014] The speed of execution at the various UTP exchanges, ECNs and in Nasdaq SM varies, as well as the parameters, protocols and exceptions for orders receiving automated executions. The ability to execute a large order in many markets can be subject to significant delays or unwanted costs. Some investors or broker-dealers avoid certain markets if, for example, speed or automated execution is important to the transaction.

[0015] A market maker's quotes in Nasdaq SM are firm quotes, meaning that market makers are obligated to purchase or sell securities at volume and price levels set by the market maker upon the presentment of an order. The number of shares

quoted by a market maker and the price selected are functions of each market maker's own risk in committing its capital to be at risk if short, or to carry an inventory of securities, and to maintain a long or short position until it can trade out of or unwind the position. Any inability to unwind a position, particularly for market makers with less capital to risk, may impair their own ability to make markets of any size.

[0016] For those market makers that offer some form of automated execution service, several developments have made it more difficult to operate those auto-ex services for larger orders or during certain market conditions. Market making spreads (and profits) have narrowed significantly over the last few years, particularly with the competition of ECNs and alternative markets, and due to the advent of decimalization and the one-cent minimum price increment. Market makers trading Nasdaq securities, therefore, have found it more difficult to take risk by devoting capital to execute transactions or to carry long or short securities positions in inventory. These developments have caused market makers to reduce their ability to provide automated executions in response to customer orders, or they have limited the size of the order to reduce overall capital commitments, particularly at or near the NBBO where risk that a firm quote execution is more likely. The NBBO price, therefore, may be "flickering," with little trading interest or depth, but there may be greater willingness to trade or commit capital, and larger volume levels, at prices outside the NBBO and often at graduated levels of pricing.

[0017] Because of decimalization, a one-cent minimum price increment, and market fragmentation, investors, dealers and market makers find it more difficult, time consuming and expensive to obtain a quick execution of a larger order. There is a wide range of price points quoted by intermediaries in different markets that investors may need to access in order to execute a larger order, as well as the ability for a market maker to trade out of the position and reduce its own inventory risk. Prices, and available liquidity, are known to move in split second timing due to other trading interest

in the market, such that a quote in Nasdaq SM, a UTP exchange or in an ECN may not be available by the time an investor or other market maker attempts to execute an order against a market maker's firm quote. This can further change the ultimate price of an execution, delay execution due to a lack of available liquidity and create principal trading risk for market makers.

[0018] Many investors have a need for immediate execution, and many professional traders have sophisticated trading strategies for which they need to hedge or reduce their risk by purchasing a large block of securities. Therefore, speed and certainty of execution and a consistent price related to the NBBO can be an important trading characteristic that cannot be executed efficiently through a series of orders directed to various fragmented markets. Thus, there is a need for an automated execution system for securities transactions that enhances the speed and certainty of the transaction, especially for large orders.

SUMMARY OF THE INVENTION

[0019] The present invention enables market makers to deliver to investors, brokers, dealers and other market makers (users) an automated execution service, typically of a larger order size, that captures available liquidity in one or more market venues selected by the user and meeting a user's need for speed and certainty of execution, including Nasdaq SM, certain UTP exchanges and certain ECNs, and capturing any undisclosed customer limit orders held by a market maker, all with the added benefit of reducing ticket charges, trading fees and the market impact of a transaction.

[0020] The present invention also permits market makers to deliver to users an automated execution of larger size orders immediately at a "net price" based on the size weighted average price (SWAP) of securities traded in selected market venues, and

with only one ticket charge, instead of separate partial fills and trade execution fees for each execution. A market maker also may permit a user to obtain automated executions of larger size orders immediately on a riskless principal basis, either obtaining a series of executions and prices, or requesting a single weighted average price. The execution module can rank each market venue and thereby decide whether to include or exclude them when pricing or executing orders based on an evaluation of speed, costs, quality of executions and other factors. A net price principal execution would attempt to reduce the market impact of a larger order because the SWAP executions may access a market maker's internal limit order book and reducing the number of lay-off transactions by the market maker.

[0021] In accordance with the present invention market makers can efficiently manage trading risk and inventory replenishment or reduction using an integrated front end and back end computer network designed to maximize trading speed and efficiency. In particular, a market maker can immediately execute transactions in response to customer orders, on a principal or riskless principal basis, to permit the market maker to run an automated execution system under most market conditions and at larger order sizes. The risk management element includes an ability to route orders to the most advantageous market venues necessary to complete the order and to tap possible hidden pools of liquidity. The system also may enhance liquidity and execution of customer limit orders and reduce or unlock locked and crossed markets.

[0022] Unlike other prior systems which attempt to create a network to deliver consolidated market information, data, analytics and order entry to terminals used by end-user investors, such as disclosed in U.S. patent no. 6,278,982, assigned to Lava Trading, Inc., the present invention is an integrated front end and back end service for market makers to provide investors with an automated execution service using only select market venues to maximize speed and certainty of execution and to manage inventory risk.

[0023] The invention uses various front end linkages to broker-dealers and institutional investors; internal market maker/dealer order book management and integration; and back end linkages to Nasdaq SM, UTP exchanges and ECNs to deliver aggregated liquidity from disparate market venues, while enabling a market maker to manage risk by accessing liquidity and executing orders in such market venues to replenish or reduce inventory. Users can obtain market pricing and volume information from various trading venues, and from an internal limit order book maintained by the market maker, and to select those venues that offer the user and/or market maker to maximize the speed and certainty of an execution, to pre-select the mode of execution (principal/riskless principal) and to determine execution pricing (net price, trade for trade riskless principal or average price riskless principal).

[0024] From direct and indirect data feeds from and to these market venues, a market maker, as the operator of the system, can select those venues to receive and transmit data and provide a user different venues from which to obtain pricings and executions and that meet the market maker's and the user's trading and risk management needs. The system operator then can determine those markets with the best prices and different volume levels necessary to respond to a customer order. In response to a customer or user order, the system will permit the system operator to compile pricing and volume information from the trading venues selected. For a net price trade, the system will determine the best available prices in the trading venues selected and use that data to calculate a size weighted average price (SWAP) incorporated into the net price. The net price includes the SWAP and a pricing component that relates to a market maker's risk for trading as principal.

[0025] In accordance with the invention, a user, when linked electronically through their computer terminal, can query the system to obtain sample net price quotes and/or to send an order to a market maker as a system operator to execute an order. The sample quote presentation may be provided as a graphic display of available

liquidity and pricing at the NBBO, within Nasdaq SM and with an automated execution by the system operator at a net price as principal using the system, and a comparison of the number of executions needed to obtain NBBO and Nasdaq SM executions as compared to a single trade at a net price using the system.

[0026] Upon receipt of a net price order by the market maker, the market maker's computer system will query pricing and volume information from selected market venues and determine the SWAP and net price. If a user selects a net price trade, the system will permit the market maker to first execute the full size of the order instantaneously as principal with the investor. The market maker will be at risk, but also can use the system to reduce that risk by immediately taking the securities purchased from the user and selling them to trading venues willing to purchase, or taking the securities sold to the user and purchasing additional shares in select venues to replenish inventory, if necessary. The system's algorithms, and access to alternative market venues, permits the market maker to select the best market or markets to reduce its trading position or risk, and in the most efficient manner. To the extent the market maker maintains an internal limit order book, it may offer an opportunity to decrease the market impact of an order, because the market maker may be able to internally execute those limit orders without executing corresponding transactions in other market venues and related trade reporting. This feature provides customers anonymous trading via internalization and protection of other customer limit orders.

[0027] For riskless principal transactions, the service permits a market maker to access trading information in various trading or market venues, including Nasdaq SM, UTP exchanges and those ECNs of which it is a member, and execute orders against available liquidity in those markets, including those ECNs that are included by the system operator.

[0028] The present invention allows users to choose to submit market, market with cap, or limit orders. A market with cap order allows the user to specify the price up

to which orders should be executed automatically, leaving any unfilled quantity to be executed manually on a market not held basis or possibly configured to reject the balance. For example, when a user clicks an "AutoFill Limit" button, an order is sent that specifies as a limit or market cap price the price returned in the last snapshot sample quote.

[0029] Because a system operator can access Nasdaq SM, UTP exchanges and ECNs directly, it can obtain pricing and volume information necessary to determine whether there is sufficient liquidity in the market to exercise the full size of the order, and if so, to electronically and automatically execute orders in those trading venues. It also may use internal or other pools of liquidity to reduce risk. These features permit a market maker to manage its market making and capital commitment risks, thereby enhancing its ability to operate an automated execution service handling larger sized orders on a more continuous basis.

DESCRIPTION OF THE DRAWING

[0030] These and other advantages of the present invention will be readily apparent from the following specification and attached drawing wherein:

[0031] FIG. 1 is a screen shot of an exemplary order entry screen for use with the present invention, shown after a quote or an order has been requested to purchase 15,000 shares of COMS stock.

[0032] FIGS. 2A-2C are screen shots of exemplary status screens which maintain the status of the various open positions and closed positions using the present invention.

[0033] FIG. 3 is a block diagram of an automated securities execution system in accordance with the present invention.

[0034] FIG. 4 is a data flow diagram of the software in accordance with the present invention.

DETAILED DESCRIPTION

[0035] The present invention relates to an automated execution and risk management system for transactions in securities. The system facilitates quick execution of orders, particularly larger orders, of securities for various clients, including broker-dealers and their customers and for institutional investors, whose paramount objectives for any particular transaction are the speed and certainty of an automated execution for an order size typically greater than the size displayed at the NBBO. The system, in accordance with the present invention, enables various users to capture greater depth and liquidity immediately and automatically and in a single execution (or in single or multiple riskless principal executions), unlike known systems which result in delayed or multiple executions, often at different prices, with multiple access fees and related costs. As such, the system, in accordance with the present invention, minimizes the risk that markets may move while an order is being filled.

[0036] In accordance with an important aspect of the invention, as will be discussed in more detail below, orders, including larger size orders, are automatically executed as principal in one transaction and a net price that includes a size weighted average pricing synthesis of fragmented liquidity. In accordance with another aspect of the present invention, the system provides users with access to displayed and certain undisplayed liquidity efficiently in one automated net price transaction or a single or in multiple riskless principal transactions, typically in sizes greater than the displayed NBBO size. In particular, the system operator assumes the capital risk for executing orders as principal and assumes the market risk. Because the system permits an operator to trade as principal or riskless principal to fill the complete order size on an

automated basis, investors have a greater likelihood of obtaining liquidity and completing their transaction immediately. The system manages trading and inventory risk by integrating internal order book and multiple market venues.

EXEMPLARY ORDER SCREENS

[0037] An exemplary order screen in which a user can enter orders to purchase or sell securities is shown in FIG. 1 and identified with the reference numeral 20. An order entry screen 22 may also include a display of the status of open and closed positions and comparison quotations, as illustrated in FIG. 2A. Alternative status screens for maintaining the status of the various open and closed positions are shown in FIGS. 2 and 2C.

[0038] Referring to FIG. 1, a user enters the type of transaction by typing a "B" for buy or "S" for sell, the number of shares and the trading symbol of the security (for example, B 15000 COMS means buy 15,000 shares of the security COMS) in an order entry box 24. A snapshot quote can be obtained by pressing a "Snapshot" button 26. A "Reload" button 28 provides additional sample quotations. A "Place Order" button 30 is provided for placing orders. When the "Place Order" button 30, or "AutoFill Limit" 47 button (FIG. 2B), is depressed, the system will execute the order as discussed below. A user may also enter a limit order price into the order entry box 24 (FIG. 1) along with the number of shares and the volume.

[0039] In response to a snapshot quotation (or reload) request or a Place Order request, the system may be configured to display the requested order information, along with the following information. For example, the order entry screen 20 may display the number of shares from zero to the size of the order in equal increments, i.e., 0-15,000 in increments of 3000 as shown in FIG. 1. The order entry screen 20 may also display a

series of comparative information in several formats, for example, a plurality of bar graphs 32, 34 and 36, comparing pricing and execution information for the NBBO (national best bid and offer), SUMO (Nasdaq SuperMontage) and AUTOFILL (net price SWAP transaction). The bar graphs 32, 34 and 36 may display the number of shares available at the NBBO, in SUMO and through AUTOFILL. If an order size is too large, the graph will display a message "not enough liquidity" to indicate that there are not enough quotations in the market for AUTOFILL to complete the full size of the order.

[0040] The order entry screen 20 may display the number of shares available at the NBBO and the price of all shares available at the NBBO under the term "Availability" in a box 38 labeled NBBO. Similarly, a box 40 labeled "SUMO," may be used to display the number of shares available in SUMO and the average price of all those shares under the term "Availability". An AUTOFILL box 42 may be used to display the number of shares requested by the user and show either the snapshot quote or the number of shares actually executed and the net price using the SWAP pricing under the term "Availability". If the user is set up to have orders executed on a riskless principal basis, instead of a net price basis, the AUTOFILL box under the term "Availability" may indicate the number of shares executed and the average price of all shares executed. The NBBO, SUMO and AUTOFILL boxes 38, 40 and 42 may indicate the number of separate executions or ticket charges the user would incur if the user separately were able to execute all shares at the price quoted at that point in time. For example as shown, in the sample Snapshot illustrated in FIG. 1 or order for B 15000 COMS, the user could have obtained 3600 shares at the NBBO price of $4.66 in 12 separate executions or ticket charges, the user could have obtained 13600 shares in SUMO at $4.6983 in 22 separate executions or ticket charges, or the user could obtain all 15000 shares at a net price of $4.68046 in one execution. For all net price trades, the number

of ticket charges in the AUTOFILL Tickets box will always be one. As noted in the example, the net AUTOFILL price also may be better than the price in SUMO.

[0041] Orders can be cancelled by checking a "CANCEL" box 43 (FIG. 2A) on the status screen 22. Alternatively, orders can be cancelled and replaced by way of a "CR" (cancel/replace) button 49 (FIG. 2A). Depressing the cancel/replace button 49 causes orders to be cancelled and replaced with orders entered into a "short hand order" box 45. An AutoFill limit button 47 (FIG. 2B) is also provided. The AutoFill limit button initiates a limit order using the snapshot quote as a limit price.

[0042] As an alternative display format, a user may select the alternative line graph button 44, which will display the same information as discussed above using line graphs and color coding to differentiate between NBBO, SUMO and AUTOFILL. The line graph displays the number of shares, the prices and the number of ticket charges.

SYSTEM DIAGRAM

[0043] FIG. 3 illustrates an exemplary embodiment of a block diagram of the automated execution and risk management system for transactions in securities in accordance with the present invention, generally identified with the reference numeral 101. The system 101 may include a number of exemplary software modules, as shown, implemented in one or more servers. For the exemplary embodiment shown in FIG. 3, the system 101 may include a QFIX_CMM module 103; a QFIX_BRASS module 105; a BRASS PowerData feed 107; a rules engine 109; a price module 111; a pre-execution module 113; an execution module 115 and an atomic order router 117.

[0044] The QFIX_CMM module 103 is a gateway or portal for all clients. In one embodiment of the invention, the QFIX_CMM module 103 is configured as a financial information exchange (FIX) engine that allows clients 121 to communicate over a

network atomic order router 117, which may be a secured network, such as virtual private network (not shown) using FIX protocol. FIX protocol is an open-source protocol that defines the format of messages on a session-level interaction between two applications, such as an application between clients 121 and the QFIX_CMM module. Additional information regarding the FIX protocol is available at www.fixprotocol.org.

[0045] It is to be understood that communications between the clients 121 and the system 101 may be other than by way of the FIX protocol. Virtually any communication protocol can be used. The FIX protocol described and illustrated is merely exemplary.

[0046] The system is configured to allow clients 121 to send orders, request snapshots and reload requests. Cancel and cancel/replace requests may be accepted for orders that have not been completely filled. Orders sent by clients 121 using the FIX protocol are received by the QFIX_CMM module 103 which may convert the order to a different protocol after which the order is passed on to the QFIX_BRASS module 105. The QFIX_BRASS component 105 monitors the system's open order book, as maintained by a BRASS feed 107. The BRASS feed 107 may be, for example, a PowerData feed, available from SunGard Trading Systems/BRASS (www.sungard.com). The Brass PowerData feed 107 provides a single point of access to multiple trading venues 123, such as multiple electronic communication networks (ECNs) maintained, for example, by BRUT, Island, Archipelago and Instinet, B-Trade, and the Nasdaq SM. In particular, the PowerData feed 107 is a digital feed of real time exchange and market data for integration into dynamic applications. This feed 107 synthesizes price and trading information into a single data stream.

[0047] The QFIX_BRASS module 105 communicates with a rules engine 109, a price module 111 and pre-execution module 113 in order to process orders for securities as shown in FIG. 3. Orders are executed by a "dumb" order system which may include an execution module 115 and an atomic order router 117. The pre-

execution module 113 and the execution module 115 are available form Magic Works, LLC, East Windsor, New Jersey. Other software is also suitable, such as PowerNet, available from SunGard Trading Systems (www.sungard.com). The source code for the Atomic Order Router 117 is contained on the compact disk Appendix.

RULES ENGINE

[0048] The rules engine 109 is a database-driven component that defines specific rules for each customer. For orders marked with a special flag (i.e., AutoFill flag) that meets the requirements set forth in the rules engine 109, the order is sent first to the price module 111 and subsequently to the pre-execution module 113. The rules engine 109 allows each order to be customized for each customer or user. As such, orders may be configured to create rules at the following levels: customer, symbol, price level, branch, order (buy or sell), trade mode (risk, riskless, agency model), takeout mode and quantity and stored in a database before any orders are placed.

[0049] The rules engine 109 may also be used to determine customer pricing. The rules engine 109 can be used to regulate on a per-customer, per-branch basis the quality of execution pricing above and beyond liquidity available in Nasdaq's SM, the number of price levels within ECN books, as well as the system operator's own order book.

[0050] Risk management rules may be used to determine the trading mode and manner in which the orders are to be handled. For example, the system may be configured to handle trades on different levels as follows:

[0051] • Number of pricing levels to be included on a per customer/branch/symbol basis.

[0052] • Which price levels to use, and what percentage of each.

[0053] • Percentage of Liquidity check rule specifies that if an order is less than a configurable percentage of NBBO size, do not perform auto-takeout unless customer is riskless principal.

[0054] • The Rules Engine may also provide a rounding rule configurable for all conventional rounding methods.

[0055] • risk principal – Transactions are automatically executed at a size weighted-average pricing synthesis of fragmented liquidity.

[0056] • riskless principal – The system may also be configured to enable securities transactions in a riskless principal mode. Riskless principal trading relates to orders filled utilizing the actual market maker execution price plus a mark-up or mark down and separate ticket charges for each transaction.

[0057] • agency mode – This mode includes riskless principal trades where a market maker delivers a single execution to the customer using the average price of executions plus markup/markdown and a single ticket charge.

[0058] The rules engine 109 can also be used to assign a pricing component that relates to a market makers risk for trading as principal. This pricing component may be integrated into a net price principal trade and reported to the tape as such.

PRICE MODULE

[0059] A price module 111 computes the pricing, utilizing the various business rules from the rules engine 109. The price module 111 receives requests from the QFIX_BRASS module 105 and determines the quantity and price or prices at which the order is executed. The system may also provide a rounding rule configurable for all conventional rounding methods.

[0060] For AUTOFILL net price trade modes, the price module 111 calculates a net price as discussed below for the order and posts it in the box 42 (FIG. 1) on the order entry screen 20. An example of a SWAP price calculation is provided below. Data from the price module is then passed on to the pre-execution module 113. The pre-execution module 113 plans and monitors execution of large orders from the QFIX_BRASS module 105. In general, the execution module 115 receives requests from the QFIX_BRASS module 105 for auto-takeout and logs the execution.

ORDER EXECUTION

[0061] Orders may be executed by way of order execution module 115 and an atomic order router 117. The execution module 115 plans and monitors execution of large orders through atomic orders and enforces price limits for auto-takeout. The order execution module 115 is a "dumb" system that simply executes orders under the influence of the pre-execution module 113. The pre-execution module 113 also interacts with manual overrides and cancellations to adjust the order size. Orders from the order execution module 115 are passed on to an atomic order router 117 that executes the order. The atomic order router 117 interacts with different ECNs, as well as with Nasdaq's SM, and selects the best route for execution of an immediate order. The atomic order router 117 maintains a state machine for atomic orders and provides a status, such as acknowledged, partial fill and cancelled. Various systems may be used for the pre-execution module 113 and the order execution module 115 as discussed above.

DATA FLOW DIAGRAM

[0062] FIG. 4 illustrates a software data flow diagram for the automated execution and risk management system 101 for securities transactions in accordance with the present invention. Initially, the QFIX_CMM module 103 listens for customers to

log in. During a ready condition, the QFIX_CMM module 103 is connected to the QFIX_BRASS module 105, which, in turn, is logged into the BRASS module 107. As mentioned above, the BRASS PowerData feed 107 maintains the order book for the system. Initially, in step 119, an order from a client 121 is received in FIX format. The order is converted to another format compatible with the system by the QFIX_CMM module 103 and passed on to the QFIX_BRASS module 105 in step 123. The QFIX_BRASS module 105 checks the order to determine if it is designated as an autofill order in step 130. If not, the system reverts to the QFIX_BRASS module 105 in step 131. For non-autofill orders, the QFIX_BRASS module 105, in turn, sends the order to the BRASS module 107 in step 122. The BRASS module acknowledges the order and returns an acknowledgement to the QFIX_BRASS module 105 in step 124, which, in turn is acknowledged back to the QFIX_CMM module 103 in step 126. The QFIX_CMM module 103 converts the acknowledgement to FIX protocol, for example, and acknowledges the order back to the customer in step 128. Once an order is acknowledged, the client can receive full or partial execution for these orders and can cancel or replace any unexecuted portion of the order. Each of these commands and acknowledgements are handled in the same manner as discussed above.

[0063] If the order is an autofill order, the system 101 automatically executes the order according to a predetermined set of rules stored in the rules engine 109. As discussed above, these rules may include trade mode (risk, riskless, agency model), takeout mode and quantity. Other rules may also be incorporated. The rules are stored on a customer level. Clients of customers may be subjected to the same rules as the customer and for market makers as systems operators. As such, when customers place an order, the system 101 automatically retrieves the rules for the customer placing the order and automatically fills the order according to the rules for that customer if the "Place Order" button 30 (FIG. 1) is depressed on the order screen. Alternatively, if the "Snapshot" button 26 or "Reload" button 28 are depressed, the

system merely returns sample quotation data and comparative quotation data for the indicated transaction.

[0064] The system 101 continuously checks in step 130 to determine if autofill orders have been placed. If an autofill order has been placed, as determined in step 130, the system 101 checks the rules engine 109 in step 132 to determine if a rule exists in its database for the particular order, customer or symbol combination. If there is no rule, the order is handled by QFIX_BRASS module 105 and executed per default rules, if they exist, or otherwise as a non-autofill order in step 133. If a rule does exist for the particular customer, as determined in step 132, the QFIX_BRASS module 105 obtains the information from the rules engine 109 regarding how the order is to be processed (i.e., auto-takeout/no auto-takeout), price levels, principal auto-fill, riskless principal, trade-for-trade, or agency model-riskless with one ticket. The QFIX_BRASS module 105 utilizes this information to format a price request for the price module 111 in step 134. In response thereto, the price module 111 returns a customer execution price and the available quantity to the QFIX_CMM module 105 in step 136.

[0065] The system 101 next checks in step 138 whether the price request submitted by QFIX_CMM 103 is rejected by the price module 111. If the price request is not rejected, the system 101 next checks in step 140 the trade mode. In particular, the system 101 first determines whether the order is an auto-takeout order. If not, the system 101 determines in step 142 whether the order is marked as a principal order and whether or not there is sufficient liquidity. If so, the order is formatted and sent to the QFIX_BRASS module 105 in step 144 for execution. If there is not enough liquidity, the order is marked as "not enough liquidity available" and will revert to the QFIX_BRASS module in 105 and follow the rule for that customer in step 145. If the order is set for auto take out, the system checks whether the order is a principal order and sufficient liquidity exists as determined in step 146, and if so, the order is sent in step 148 to the QFIX_BRASS module 105 for execution.

[0066] In step 150, the system checks whether a partial fill rule exists. In particular, if the size of the order is less than a certain percentage of the overall liquidity, the order is executed in step 151. If the order size is not less than a certain percentage of the liquidity, the limit order protection is calculated in step 152. For auto-takeout orders, in a principal mode, the system 101 determines whether enough liquidity exists, in step 154. If the order is an auto-takeout order, the lesser of the original quantity or available liquidity minus limit order protection obligations as determined in steps 152 and 158 is determined and sent to the pre-execution module 113 in step 158. The trade is then sent to the QFIX_BRASS module 105 in step 160. When the trade arrives, the QFIX_BRASS module 105 formats the trades and sends it to the execution module 115 in step 164. The QFIX_BRASS module 105 checks in step 166 whether the order was a riskless principal order with multiple tickets or whether there was not enough liquidity. If yes, then the QFIX_BRASS module 105 formats the executions and sends them to the execution module 115 after each trade is sent is step 168. If the trade order is marked riskless principal with a single ticket, as indicated in step 170, a single execution will be formatted by the QFIX_BRASS module 105 and sent to the Brass module 105 in step 172 after the final message arrives from the pre-execution server 113. All requests for orders that are received by the QFIX_CMM module 103 and executed by the system are sent back to the client. A database archives all underlying orders that comprise the price returned for snap quotes, as well as for those that comprise the actual customer execution price and the risk management take-out.

NET PRICE

[0067] The net price of any AutoFill execution is comprised of two elements. All net prices are computed at the time an order is received. The first element is the size weighted average price (SWAP) of "displayed" market participant quotes on the opposite side of the order (i.e., sell orders measure the SWAP of market participant bid

quotes; buy orders measure the SWAP of market participant offer quotes).[1] SWAP calculations, including levels of displayed liquidity captured or included in a price, may vary from user to user. SWAP also will include any price improvement due to rounding of some ECN pricing data. Some market participant quotes (currently the American Stock Exchange) may be excluded from the SWAP calculation (and corresponding size/liquidity). The SWAP component may include the system operator's own market maker quotation (which may include customer limit orders) if the system operator's quote is at the NBBO or otherwise is necessary to fill the order, as well as any limit order received by system operator and displayed in an ECN. In a net price trade, the system operator may not be trading on a riskless principal basis. Therefore, the SWAP component of the net price may not be based on the system operator's own price when purchasing (selling) those shares and then reselling (repurchasing) them to the customer. The SWAP component only represents displayed liquidity in the market, but provides a useful, consistent pricing measurement directly related to the market as reflected in system operator's net price.

[0068] The SWAP price is calculated as provided below:

$SWAP = (S_1*P_1 + S_2*P_2 \ldots . \text{ to } S_n*P_n) / (S_1 + S_2 \ldots S_n)$, where

p_n = price of shares

S_n = number of shares at price pn

[0069] The second element of the net price is the risk factor. Because the system operator is trading as principal and subject to market risk, the net price may be outside the actual SWAP by an amount based on the market capitalization or liquidity of

[1] The "displayed" liquidity means market participant quotes in the national market system for Nasdaq-listed securities, including quotes by market makers and ECNs in Nasdaq's SM and the NASD's ADF, and by specialists on UTP exchanges. The displayed liquidity would not include other potential liquidity not displayed to the public; for example, it would not include any "reserve size" or undisplayed limit orders. In addition, a system operator may, from time to time, exclude from the SWAP certain quotes and volume figures from some UTP exchanges, ECNs or other market participants trading Nasdaq stocks. Omitting certain quotes and volume figures may limit a system operator's own ability to offer liquidity that may be displayed in some market centers.

the security in question, the depth of the market, the size of the order, market access fees, system operator's risk management and trading firewall policies and the trading characteristics of the user. The system operator likely will have access to all major market participants, and pay related access and user fees. The system operator may negotiate at arms length different pricing parameters including different SWAP pricing levels with each participating dealer, order routing broker-dealer or institutional customer, which may change from time to time based on the above factors.

[0070] As a principal trade at a net price, the net price will be the same price reported to the consolidated tape.

Pricing Request Protocol

[0071] Exemplary protocol for requesting pricing is provided below:

- The Liquidity Prices provider acts as a server
- The Rules Engine acts as a client
- Connection: TCP/IP, client opens connection to server on a specified port (default 31103)
- Communication between the server and client consists of ASCII text lines terminated by <EOL> sequences ("\r\n");
- (*) After the connection is established, client is prompted for login and password: it monitors input for a string "login:" and sends login string followed by <EOL> ("\r\n"); then monitors input for string "password:" and sends password string followed by <EOL>. Server sends a string starting from an error code. Error codes are: 230 (*access granted*) and 530 (*access denied*).
- (*) Client has 3 attempts for login, after third unsuccessful server drops the connection;
- After login, client ignores all lines starting with space (ASCII 32). They are debug messages. Client may log them.
- At any time if connection is lost the client must be able to detect that and reconnect to the server. After reconnection, client must (if needed) resend pending requests to the server.

SWAP Liquidity Price Request

- Client sends request strings followed by <EOL>. Each request starts with ASCII letter 'R' for SWAP liquidity specifying that this is a request for liquidity price. Fields in the request string are separated by one or more spaces (ASCII 32). Request

format is as follows:

R <request id> <symbol> [-]<number of shares> <price cap> [<ECN levels>] <EOL>

- <request id> - any unique for this session integer (client may use a simple integer counter incrementing with every request; counter is reset when the connection is established)
- <symbol> - symbol for the security
- <number of shares> - integer specifying number of shares, negative value means sell, positive – buy)
- <price cap> - could be 0 (means no cap), otherwise is treated as a double float value of the price cap
- <ECN levels> - number of ECN book levels included in the calculation, default – no limit. The server includes no more than specified number of price levels when looking for liquidity in available ECN books, although it uses all possible price levels of the NASDAQ montage (Level II or Super montage).
- <EOL> - "\r\n" sequence

Examples:
R 12345 MSFT -100 24.6 2
R 12346 AAPL 30000 0

- Server asynchronously sends reply messages. They are started with ASCII letter 'Q' and have format as follows:

Q <request id> <symbol> [-]<number of shares> <liquidity price>
(Continued from previous line) **<Market 1 SWAP data> [<Market 2 SWAP data>] <EOL>**

- <request id> - the original request id from the R message;
- <symbol> - symbol for the security
- <number of shares> - integer specifying number of shares, negative value means sell, positive – buy)
- <liquidity price> - double float value for the liquidity price
- <Market SWAP data> syntax:
  <Market Symbol>=<number of shares>:<liquidity price>

- <EOL> - "\r\n" sequence"

Examples:
Q 12345 MSFT -100 24.6 ISLD=-100:24.6
Q 12346 AAPL 10000 14.4 ISLD=100:14.4 INST=900:14.4

If the price cap is not specified in the request message, and total market liquidity is less than specified in the request, <number of shares> gives the total available liquidity.

Periodical SWAP Liquidity Price Request

This request is similar to the simple SWAP Liquidity Price Request; the difference is that the client specifies the update time (in seconds) and the server sends Q packets periodically. The first Q response is sent immediately after the request. Every consecutive Q response has the same ID as the corresponded request; this gives an opportunity to distinguish between responses even if they have the same symbol and other parameters.

Syntax for the Periodical SWAP Liquidity Price Request:

P <request id> <symbol> [-]<number of shares> <price cap> <time interval> *(continued)* **[<ECN levels>] <EOL>**

<time interval> - update time in seconds (*). Default is 1 sec.

Example:
P 12345 MSFT -100 24.6 5 2

The client will receive updates every <time interval> seconds, until it disconnects or issues an unsubscribe request in the form:

F <request id>
<request id> - the same request id as in the first P packet.

Example:
F 12345

(*) – Optional

BBO request

- This type of request starts with 'B' followed by integer request id, symbol, and <EOL>:

B <request id> <symbol> <EOL>

- <request id> - any unique for this session integer (client may use a simple

integer counter incrementing with every request; counter is reset when the connection is established)
- o <symbol> - symbol for the security
- o <EOL> - "\r\n" sequence

Example:

B 12345 MSFT

- If symbol is recognized by the server, it sends a reply starting with 'O':

O <request id> <symbol> <BBO ask>:<BBO ask size>/<BBO bid>:<BBO bid size>
(Continued from previous line) **[<Market BBO quote 1>] [<Market BBO quote 2>] ... EOL>**

<Market BBO quote> syntax:
<Market Symbol>=<Best ask>:<Best ask size>/<Best bid>:<Best bid size>

Example:

O 12345 MSFT 25.79:18600/25.78:11000 ISLD=25.79:2000/25.77:100 IST=25.79:9400/25.78:700

Periodical BBO request

This is a variation of the BBO request for the case if the client needs to receive BBO packets (type O) periodically. The syntax is as follows:

N <request id> <symbol> <time interval> <EOL>

<time interval> - update time in seconds (default: 1 sec)

The client will receive updates every <time interval> seconds, until it disconnects or issues an unsubscribe request in the form:

F <request id>
<request id> - the same request id as in the first N packet.

[0072]

[0073] Obviously, many modifications and variations of the present invention are possible in light of the above teachings. Thus, it is to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described above.

[0074] What is claimed and desired to be covered by a Letters Patent is as follows: